POLICY FORUM: ECOLOGY

Conservation Priorities for Russian Mammals

Leonard V. Polishchuk

The human impact on the environment has already caused species extinctions and may cause many more in the future (*1, 2*). Not all species are equally prone to extinction, however; slow-reproducing, long-lived, large-bodied species often go extinct first (*3, 4*). Can this general ecological knowledge be developed into a predictive theory for conservation priorities, which would guide us on how to divide limited conservation resources? This question is perhaps especially pressing for Russia, a country that has been going through a major economic changeover from a state-owned to a free-market economy associated with a shortage of resources. While Russia's protected areas have recently increased by almost 25%, and in the Arctic have doubled (*5*), some estimates indicate that the available funding satisfies merely 50% to 25% of the conservation needs (*6*).

The modern trend in conservation strategy is to direct conservation resources to "biodiversity hotspots," the regions that host the highest concentrations of endemic species (*7*). This approach, however, does not tell us how to divide resources among species within a region. An alternative approach puts more emphasis on biology and suggests dividing resources in proportion to species' probabilities of extinction. Unfortunately, we are far from having a predictive theory of extinction, except for a few well-studied species (*8, 9*).

The Red List is an international list of species (searchable by nation) that are threatened with extinction within a short time span, usually on the order of a few generations (*10*). For the Red List of the former Soviet Union (*11*), the basis for listing has always been rarity or a marked decline in population size and/or geographical range and not the species' life history. Despite the potential for subjectivity in such a listing, I have hypothesized that the chance of an organism's being listed is related to fundamental biological traits, especially when listed and unlisted species are facing the same environmental pressures.

There are data on life history and body mass for 90 mammalian species from the territory and coastal waters of the former Soviet Union (*12, 13*), of which 25 species are on the Red List of the former USSR (*11*). Five traits have been made available for each species: annual fecundity, lifetime fecundity, litter size, adult life-span, and adult female body mass. Logistic-regression models for chance of listing for each trait were determined [Fig. 1 and fig. S1 (*13*)]. Models based on annual and lifetime fecundity are better for classifying mammals than the other three and were equivalent in their performance (Fig. 2).

As annual fecundity is easier to measure than lifetime fecundity, I have used it to define a critical fecundity B_{cr} beyond which the chance of listing L becomes effectively zero. For practical purposes we can set $L(B_{cr})$ at 0.01, which yields B_{cr} = 2.9 daughters per year (Fig. 1). One-third of the species we sampled have annual fecundity larger than 2.9, which implies that concentration of efforts on the two-thirds of species remaining would effectively increase available conservation resources by 50% on a per-species basis.

How do estimates based on this approach compare with current conservation policies? According to Russia's Federal Target Program for the years 2002–2010 (*14*), the Siberian tiger and the polar bear are top priorities on the Russian conservation agenda, accounting for $16.7 and $13.7 million, respectively, of conservation resources (*14*). From the chance-of-listing standpoint, this is perfectly justified because, with annual fecundity of 0.4 (tiger) and 0.3 (polar bear) daughters per year, their chance of listing is high and approximately equal (Fig. 1). However, to have 95% of all monitoring funding resources going to these two species is out of proportion. This virtually disregards many other threatened species, such as the desman (*Desmana moschata*) (*15*), whose annual fecundity is 1.75 daughters per year (Fig. 1). If we take the funds provided for the tiger as a reference point, then the desman would have to receive $2.5 million, which is larger than the resources for monitoring of all Russian animals and plants other than the tiger and the polar bear [$1.6 million (*14*)]. Thus, within threatened species, the concept of chance of listing suggests a more uniform allocation of conservation resources than currently in use.

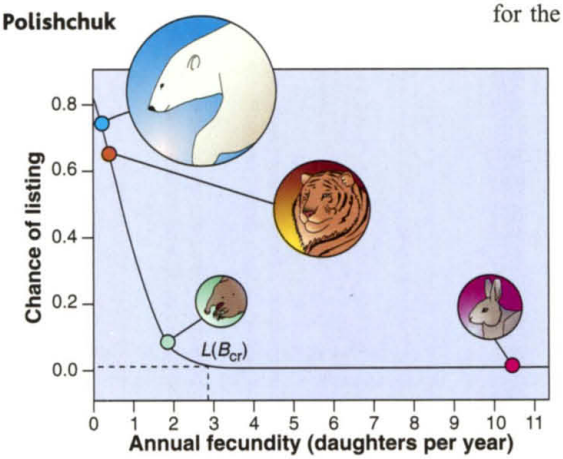

Fig. 1. The listing probability curve $L = [1 + \exp(-1.52 + 2.10B)]^{-1}$ as a function of annual fecundity B. The four representative species shown are polar bear, Siberian tiger, Russian desman, and rabbit (in order of increasing fecundity). The rabbit exemplifies a classical species with very high annual fecundity. Also shown is critical fecundity B_{cr} = 2.9 daughters per year.

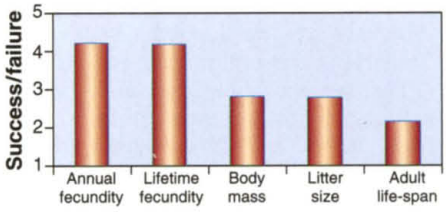

Fig. 2. Performance models for chance of listing based on retrospective classification into threatened and nonthreatened species. The success/failure ratio is the mean of correctly over incorrectly classified species (*13*).

L. V. Polishchuk is at the Department of General Ecology, M. V. Lomonosov Moscow State University, Moscow 119899, Russia, and is associated with the Department of Food Web Studies, Center for Limnology, Netherlands Institute of Ecology (NIOO-KNAW), 3631 AC Nieuwersluis, Netherlands. E-mail: LV@Polishchuk.msk.ru

References and Notes

1. O. E. Sala *et al.*, *Science* **287**, 1770 (2000).
2. S. L. Pimm *et al.*, *Science* **269**, 347 (1995).
3. T. R. E. Southwood, in *Theoretical Ecology: Principles and Applications*, R. M. May, Ed. (Blackwell, Oxford, 1976), pp. 26–48.
4. S. L. Pimm, *The Balance of Nature?: Ecological Issues in the Conservation of Species and Communities* (Univ. of Chicago Press, Chicago, 1991).
5. World Wildlife Fund, Russian Program Office, Moscow; www.wwf.ru/main.html
6. The First National Report of Russian Federation on Biodiversity Conservation in Russia (Russian Conservation Monitoring Center, Moscow, 1997); www.rcmc.ru/official/report97/Part23-e.html.
7. N. Myers *et al.*, *Nature* **403**, 853 (2000).
8. B. W. Brook *et al.*, *Nature* **404**, 385 (2000).
9. T. Coulson *et al.*, *Trends Ecol. Evol.* **16**, 219 (2001).
10. www.redlist.org
11. A. G. Bannikov, V. E. Sokolov, Eds. of section on mammals, in *The Red Book of the USSR: Rare and Threatened with Extinction Species of Animals and Plants*, A. M. Borodin *et al.*, Eds. (Lesnaya Promyshlennost', Moscow, ed. 2, 1984), vol. 1, part 1.
12. L. V. Polishchuk, V. B. Tseitlin, *Zhurn. Obshch. Biol.* **62**, 3 (2001).
13. Materials and methods are available as supporting material on *Science* Online.
14. www.priroda.ru/bibl/knigi/1748_0860_2001.pdf (conversion factor is 31.5 ruble/$)
15. www.biodiversity.ru/programs/vyhuhol.html
16. I thank A. Ghilarov, N. G. Hairston Jr., I. Hanski, A. Kondrashov, S. Pimm, Yu. Romanovsky, V. Tseitlin, J. Vijverberg, D. Voronov, V. Burmensky, and two anonymous reviewers. Supported by Russian Foundation for Basic Research (grant 01-04-48384) and the Netherlands Organization for Scientific Research.